Commissioning Building Systems

U.S. DEPARTMENT OF ENERGY
OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

THE FEDERAL ENERGY MANAGEMENT PROGRAM'S

DESIGN STRATEGIES FOR LOW-ENERGY, SUSTAINABLE, SECURE BUILDINGS

A DOE/FEMP Workshop, San Diego, CA. • March 26-27, 2003

Dr. Malcolm Lewis, PE
President
CTG Energetics, Inc.
Irvine, CA
www.CTGEnergetics.com

Commissioning Building Systems

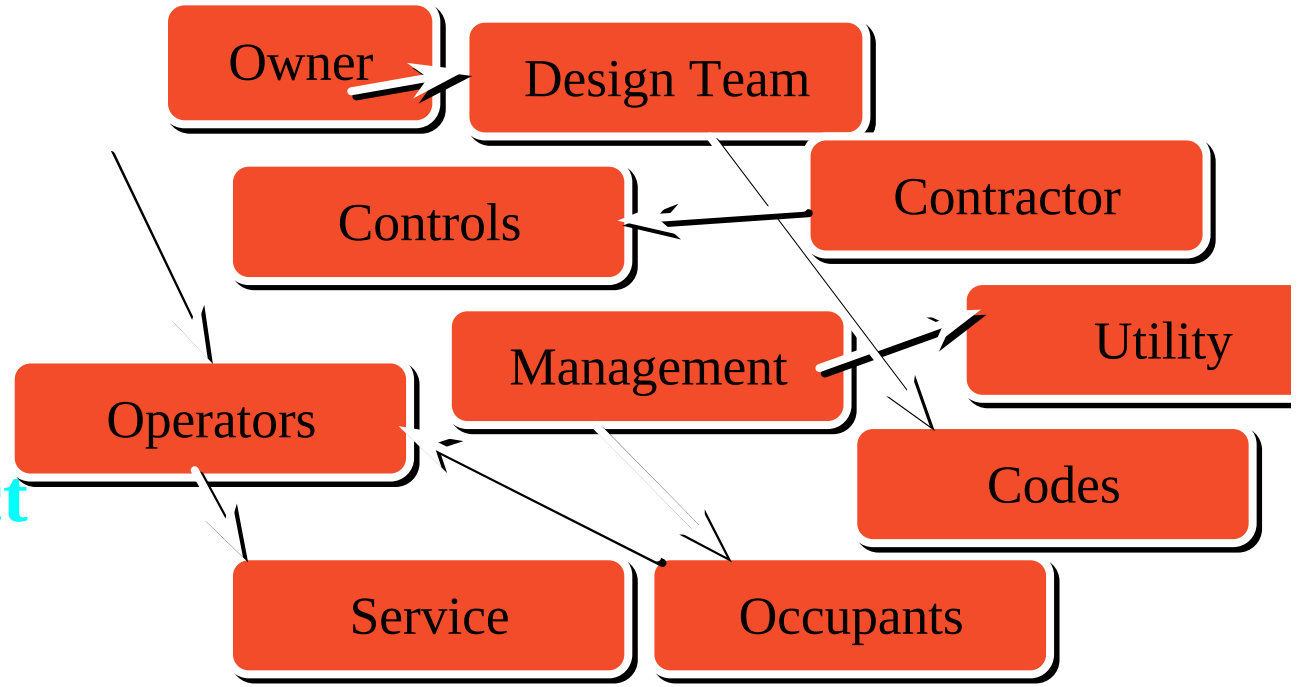
Dr. Malcolm Lewis, PE
President
CTG Energetics, Inc.
Irvine, CA
www.CTGEnergetics.com

Commissioning Outline

- What is Commissioning (“Cx”)?
- Why is it Necessary & Critical?
- What are the Elements of Cx Process?
- What are the Key Challenges?

Context for Commissioning Process

- **Fractured design and construction process creates confusing and conflicting relationships between project players**



Definitions of Commissioning

- Commissioning is:
- "…a systematic, documented, and collaborative process including inspection, testing, and training."
- "…conducted to confirm that a building and its component system meet the requirements of the occupants and conform to the design intent."
- "…a quality assurance procedure applied to building construction throughout the entire project…"

LEED and Commissioning

- LEED's Perspective:
  - Commissioning is so critical that it is required.
- Basic Commissioning – Pre-Requisite
- Additional Commissioning – 1 Credit

Characteristics of a Commissioned Building

A Commissioned Building:

- Achieves performance goals
- Minimizes Energy Consumption
- Minimizes Environmental Impacts
- Maximizes Occupant Health & Comfort
- Optimizes Life-Cycle Costs

Why is Cx so Critical?

- Buildings are very complex systems
  - Especially “high performance” buildings
  - Innovative systems need more support to reduce technical risks
- Without Cx:
  - Building systems not working properly
  - Projected savings not achieved
  - Indoor Environment not adequate
  - “High Performance” not really “High”

Bateson Building, Sacramento CA

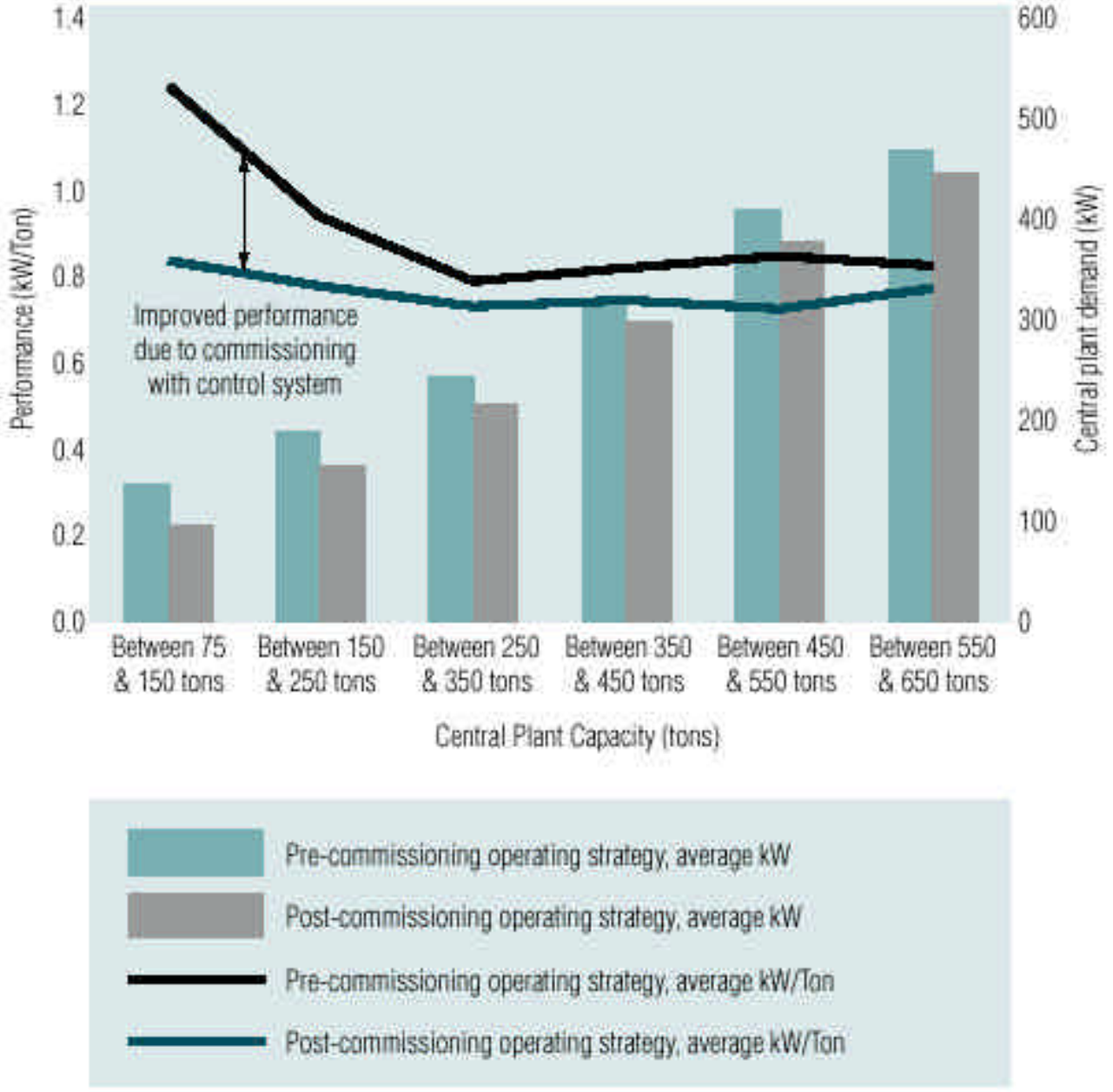
Hev ndation Headquarters, Menlo Park CA
Archtiect

Benefits of Commissioning

- Construction Efficiency
- Energy Efficiency
- Overcoming Technical Risks of Innovation
- Improved Indoor Environmental Quality (IEQ)
- Occupant Productivity
- Reduced Liability Claims
  - Design
  - IAQ

Value of Commissioning HVAC Systems

Even short-term commissioning can substantially improve energy efficiency.



Problems that Commissioning Solves

- Design Goals/Criteria Forgotten or Distorted
- Designs Aren’t shown Completely as Intended
- Construction Deviates from Design
- Systems Not Fine-Tuned at Start-Up
- Operators Not Properly Trained
- Systems Not Maintained

Commissioned Systems in a Green Building

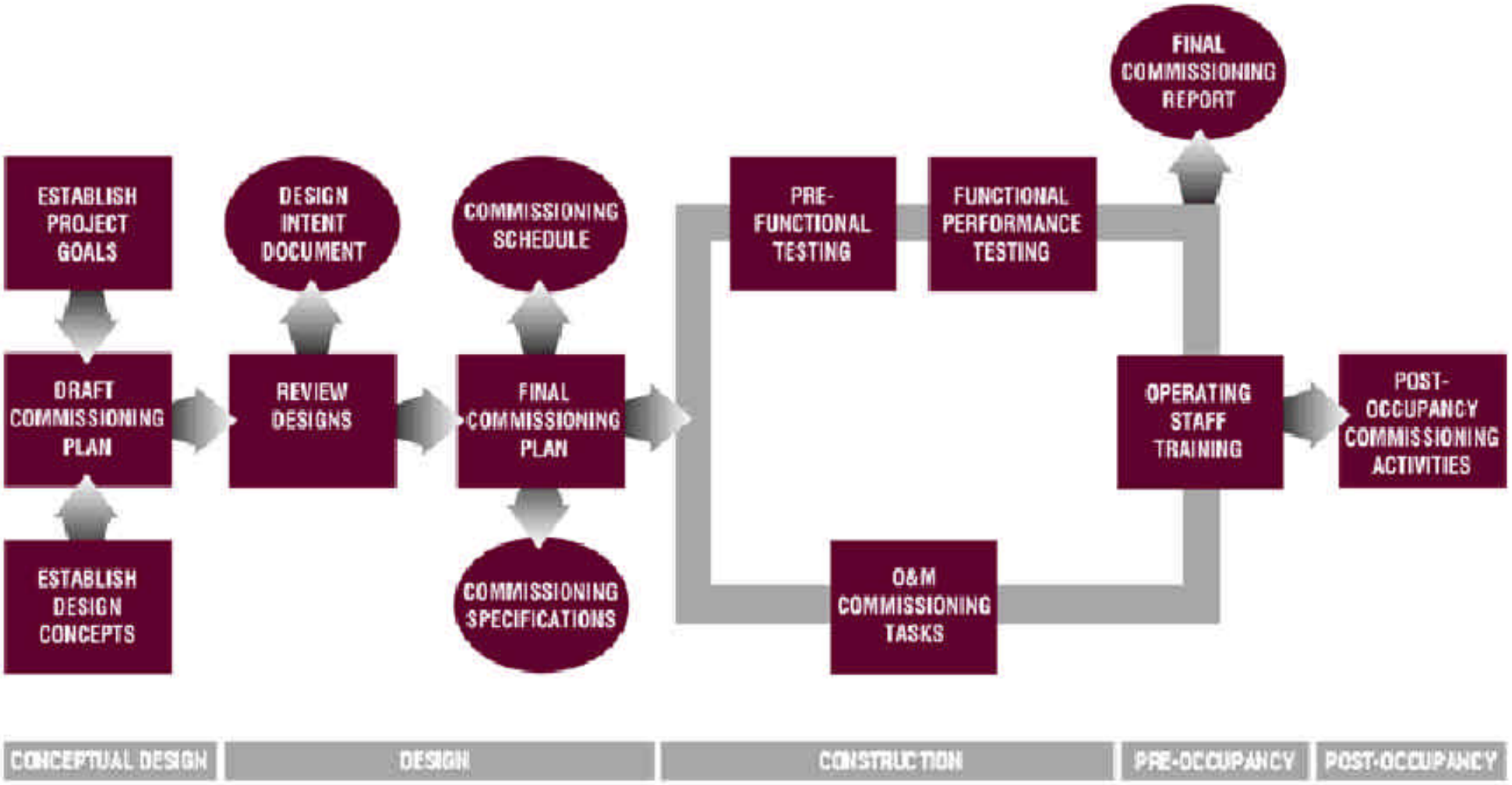
- Lighting Controls
- Sun Controls / Shading
- Demand Controlled HVAC / Ventilation
- Ventilation Systems and Control
- Gray Water
- Storm Water Control
- Photovoltaics / Cogeneration / Fuel Cells
- Direct Digital Controls (DDC)
- Central Plants
- etc.

What are the Elements of Cx Process?

- Decision to do Commissioning
- Designation of Commissioning Provider
- Integrating Commissioning into the Project
  - Design
  - Construction
  - Post-Construction

Role of Commissioning Provider

- Focused on Commissioning Activities, not Design details
- Separate function from design
- Knowledgeable in functional areas
- Team Player
- Less effective if not involved EARLY

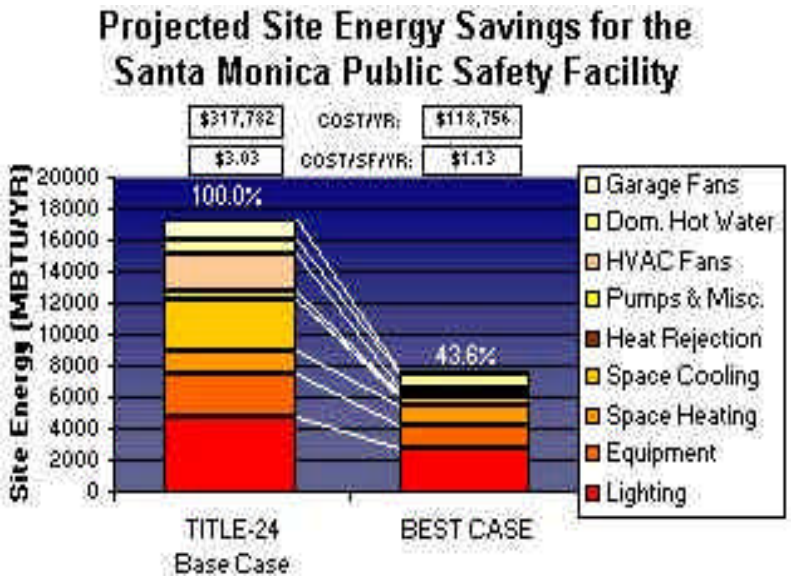

ESTABLISH PROJECT GOALS
DESIGN INTENT DOCUMENT
COMMISSIONING SCHEDULE
PRE-FUNCTIONAL TESTING
FUNCTIONAL PERFORMANCE TESTING
FINAL COMMISSIONING REPORT
DRAFT COMMISSIONING PLAN
REVIEW DESIGNS
FINAL COMMISSIONING PLAN
OPERATING STAFF TRAINING
POST-OCCUPANCY COMMISSIONING ACTIVITIES
ESTABLISH DESIGN CONCEPTS
COMMISSIONING SPECIFICATIONS
O&M COMMISSIONING TASKS
CONCEPTUAL DESIGN
DESIGN
CONSTRUCTION
PRE-OCCUPANCY
POST-OCCUPANCY

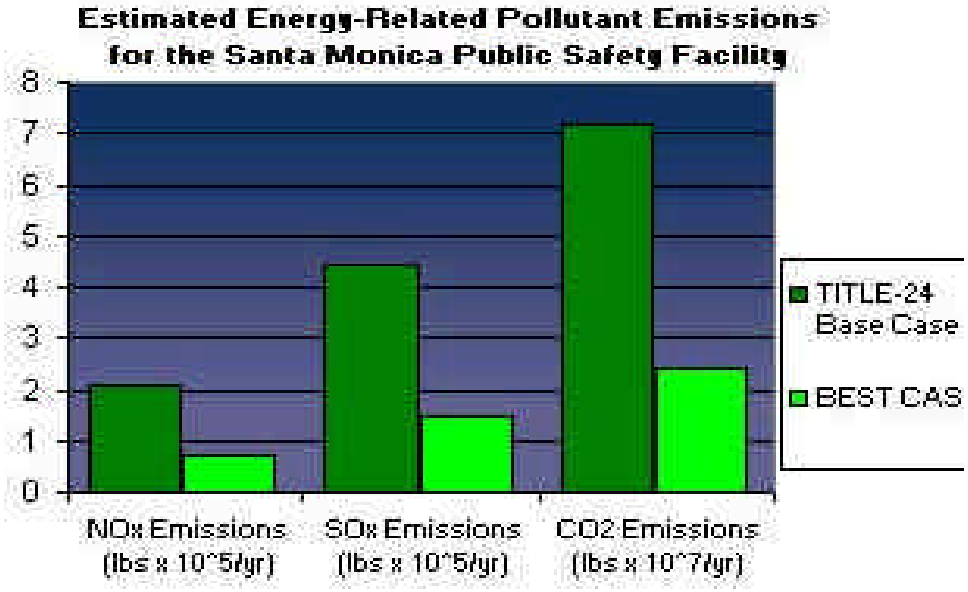
Commissioning Documentation

- Design Intent Document
- Commissioning Schedule
- Functional Test Plans
- Specifications
- O&M/Training Info
- Commissioning Report
- Monitoring & Verification Reports

Design Intent Document

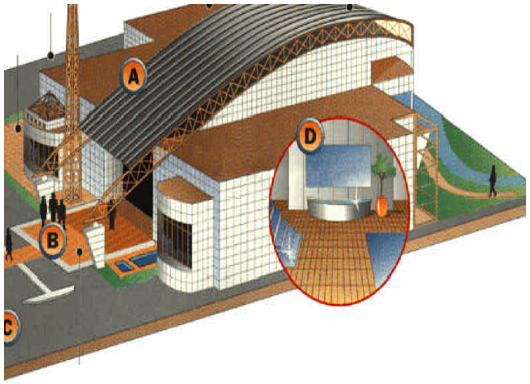
- Set Original Goals for Performance:
  - Energy Performance
  - Environmental Performance
  - Comfort
  - Operating Cost
- Determine how Performance vs. Goals is to be Measured





Verify that Design Intent is Met

- in Design
  - Verification of Goals in Documents
  - Coordination between Design
  - Disciplines
- in Construction
  - Procurement of Equipment and Materials
  - Installation
- at Start-Up and Testing
- in Operations



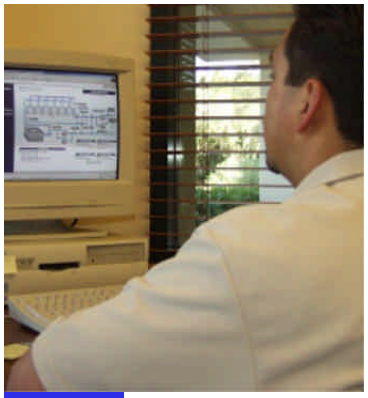
Start-up and Testing

- Operational Testing
  - Static Testing to Ensure Proper Installation
  - Functional Testing to Measure Performance
    - System Capacity
    - Control Strategies
    - Energy Efficiency

lation of Temperature monitoring equipment

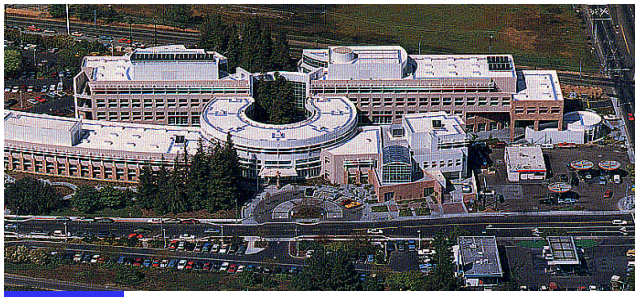
Start-up and Testing (cont)

- Validate/calibrate performance measurement
  - Energy
  - Environmental
- Train Building Operators
  - How Systems Work
  - How to Operate Systems
  - How to Maintain Systems



Training Activities

- Coordinated by Commissioning Provider
- Included in Specifications
- Formal Classroom Training of Operators
- Follow-On Training



SMU lquarters, Sacramento
Will addon

Commissioning Challenges

- Comprehension
- Commitment
- Integration
- Budget
- Schedule
- Procurement
- Technical
- Follow-Through

SMU Headquarters

Commissioning Challenges: Comprehension

- Of the need
  - "Isn't the design good enough?"
  - "I already pay for QA/QC and Start-Up and TAB"
- Of the process

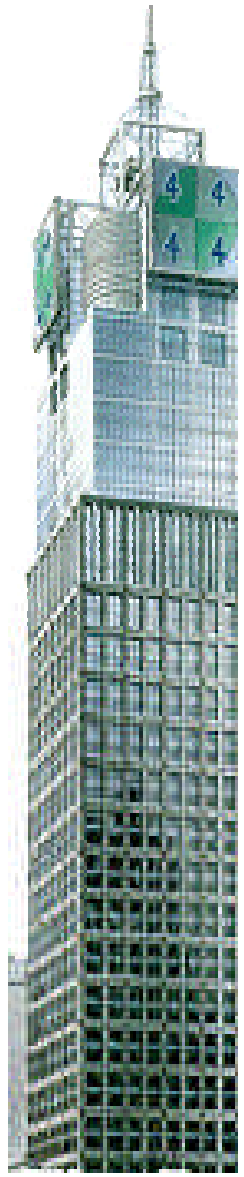
Pitts onvention Center, Pittsburgh PA
Raf y

Commissioning Challenges: Commitment

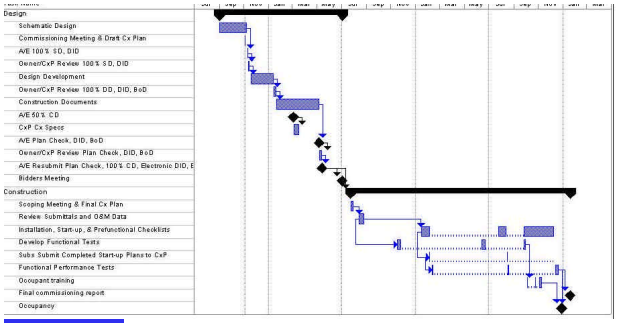
- Include all disciplines & participants
  - Owner
  - Design Team
  - Contractors
  - Operators
- Include Cx from the beginning
- Stick with it!

Commissioning Challenges: Budget

- Cx costs 2-4% of Systems Commissioned
  - 0.5 - 1% of Total Project Construction Cost
  - Depends on Scope, Project Size
  - Depends on Level of Cx
- Pay now or Pay More Later!
- How to minimize?
  - Avoid duplication with tasks already in someone's Scope
  - Make Cx part of the project expectations from the start.
  - Involve O&M Staff in Cx



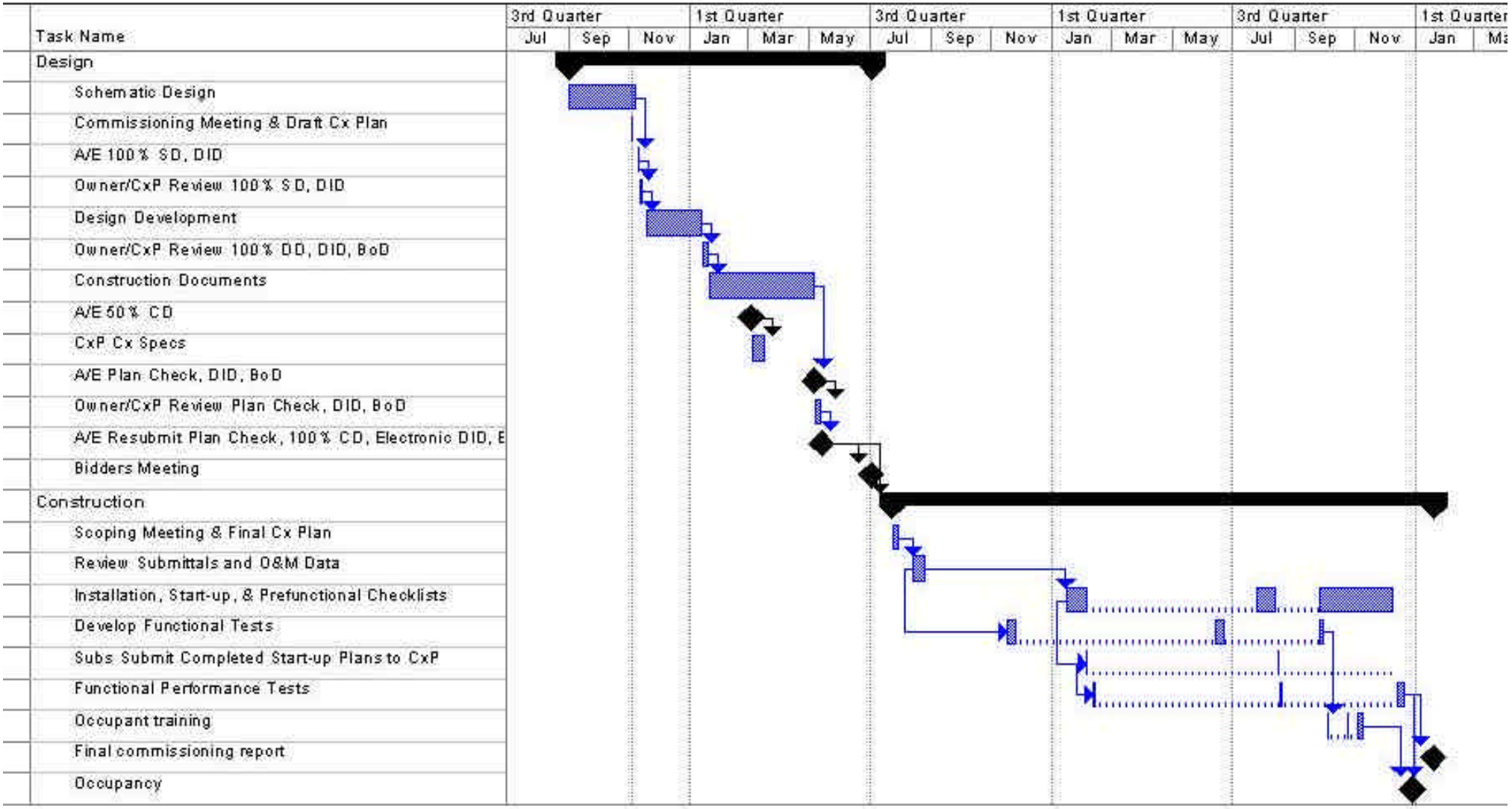
4 Times Square, New York
Fox & Fowle Architects



Commissioning Challenges: Schedule

- Schedule Cx Activities throughout
  - Involve Commissioning Provider early
  - Begin Commissioning Process in the design phase
  - Allow for iterative design refinement
  - Allow time to correct deficiencies found by testing
- Cx *will* be on the Critical Path at the end

Typical Commissioning Schedule



SC y Resource Center, Downey CA
WL ects

Commissioning Challenges: Integration

- Throughout design & construction
- Role of Commissioning Provider
  - CA is part of the Team.
  - Don't "shoot the messenger!"
  - Finding problems is a Success in Cx!
    - The problems have to get fixed by the Construction Team.

Commissioning Challenges: Procurement

- Design-Build puts Cx under Contractor
  - Potential conflict of interest
- Low Bid procurement
  - Requires a very tight Cx Spec

Commissioning Challenges: Technical

For[illegible]r Auto Group Headquarters, Irvine CA
LPA[illegible]cts

- What level of Cx is desired or needed?
- Many new technical challenges with innovative new systems.
- How do you commission Shell & Core Systems when T/I's not done?
  - Shell - HVAC
  - T/I - Underfloor Air

Get r, Los Angeles CA
Rich er

Commissioning Challenges: Follow-Through

- Operations Staff:
  - Understanding Design Intent
  - Participating in Commissioning Process
  - Implementing Operating Strategies
  - Maintaining Trained Operators on Staff
  - Monitoring Operations against Performance Goals

Gap erry Offices, San Bruno, CA
Will onough (Design) Gensler (Production)

Summary

- Commissioning “bridges the gap” between Possibility & Reality
  - Verifies that Design Intent is Met
  - Monitors Construction Compliance with Intent
  - Assures Systems Operate as Intended
  - Validates/Calibrates Performance Measurements
  - Trains Operators

Summary

- Key Elements of Successful Commissioning
  - Committed Owner and Team
  - Commissioning Provider present Early in project
  - Team Approach to Design & Construction
  - Early O&M Personnel Involvement

Resources

- FEMP Building Commissioning Guide
- NAVFAC Commissioning Web Site

BUILDING
COMMISSIONING
GUIDE

VERSION 2.2

Sponsored by:

U.S. General Services Administration
Public Buildings Service
18th and F Streets, NW
Washington, DC 20405

and

U.S. Department of Energy
Federal Energy Management Program
1000 Independence Ave., S.W.
Washington, DC 20585

July 30, 1998

http://www.eere.energy.gov/femp/techassist/bldgcomgd.html

Copyright Notice